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Biosynthesis of Gold Nanoparticles from the Plant-based Origin and Its Potent Application in Detection and Termination of Carcinogenic Cells

Saikatendu Deb Roy
Department of Chemistry, National Institute of Technology, Silchar, Assam

Krishna C Das
Department of Chemistry, Gurucharan College, Silchar, Assam

Siddhartha S Dhar
Department of Chemistry, National Institute of Technology, Silchar, Assam
Corresponding Email: *kcdas19@gmail.com*

Abstract

Plant-based synthesis has always been a choice for researchers for facile and efficient synthesis of the particles in the nano diameter range. Gold nanoparticles are known for their efficient size-dependent tunable optical properties and their potent application in catalysis, photonics, nanoelectronics, and disease diagnosis. The size variation leads to the development of various catalytic applications and the reusability of the same. The green method can be applied over the convention method to ensure better and low-cost synthesis of nanoparticles. The review's primary focus is to provide the locally available plant species origin, including leaf, stem, flowers, etc., for the facile synthesis of nanoparticles and to study the application of gold nanoparticles. The overview lays on the application of gold nanoparticles for cancer treatment alternative having future in cost-friendly nanomedicine.

Keywords: *Greener Approach, Nanoparticles, Low-cost Synthesis, Nanomedicine, Cancer Treatment*

Introduction:

Gold nanoparticles are known for their unique properties [1–7]. The gold nanoparticles are of immense interest due to the process of synthesis, size, shape, and biocompatibility, and they find significant applications in the fields of catalysis, nonlinear optics, surface-enhanced Raman scattering, nanoelectronics, gene expression and disease diagnosis etc. [8-12]. Repeated administration of gold nano drugs may lead to the toxic accumulation of nanoparticles in the body. Hence to increase biocompatibility, nontoxic

reagents as an alternative for synthesis are to be preferred, so it is necessary to adopt alternative strategies and methods for their synthesis. Using a green choice to reduce metals oxidation state was reported earlier [13]. Many research work has been reported, including reducing and capping agents using materials of biological origin, using plant extract, or microorganisms are known to modern-day researchers [8, 14-20]. The size and shape can be controlled by properly choosing protecting agents, concentration, and optimum pH of the reaction medium. Various bio-mediated methods include plant extract, plant roots, leaf extract, and microbes [9-12, 21-32]. Biosynthesis of AuNPs using plant extract such as *Aloe vera, Cinnamomum camphora, Azadirachta indica, Medicago sativa, Pelargonium graveolens, Cymbopogonflexuosus Tamarindus indica, Coriandrum sativum* has been reported [33-42]. The green synthesis method is an alternative to ensure environmental safety, highly economical, limiting the use of harsh chemicals, and reducing the toxicity of nanoparticles.[43-46]The present review has been focused on the synthetic strategy using the plant-based origin and outlining some of the potent applications of gold nanoparticles in the treatment of cancer.

Biosynthesis of Gold Nanoparticle:

The Greener technique is always preferred over the conventional methods to reduce the oxidation state of metal. Various research work includes the use of reducing agents of biological origin, including microbes and plant extract. For the synthesis of gold nanoparticles, the generally bottom-up technique is applicable. Further, the synthesis performed using leaf and flower extract seemed to be a swift technique to obtain gold nanoparticles. *Azadirachta indica* is readily available in any region and can be used to reduce Au3+ and Ag+[47]. *Aloe vera* leaf extract has been used to synthesize nano triangles[48]. Extracellular synthesis of gold nanoparticles using *Magnolia Kobus* and *Diospyros kaki* reported having more than 90% recovery of gold nanoparticles within a short time at a temperature around 90oC [49]. Stable Au nanoparticle obtained using *Emblica Officinalis* fruit extract as a reducing agent[50]. *Cinnamomum camphora* leaf extract has potent application in the synthesis of Au nano particles[51]. The leaf extracts of *Salvia officinalis, Lippiacitriodora, Pelargonium graveolens,* along with the fruit extract of *Punica granatum,* are known to have sizes ranging from10nm to 150nm with a variety of geometrical shapes [52]. Flower extract including petal extract and leaf extract can be used to synthesize Au nanoparticles and the size can be varied based on the content basis[53-55].

Table 1: Various Plants used for the synthesis of gold nanoparticles

Sl no	Plants	Nano size	Reference
1	*Avena sativa*	5–20 nm	[65]
2	*Azadirachtaindica*	50–100 nm	[66]
3	*EmblicaOfficinalis*	15–25 nm	[67]
4	*Cinnamomumcamphora*	55–80 nm	[68]
5	*Tamarind Leaf Extract*	20–40 nm	[69]
6	*Salvia officinalis*	10nm	[52]
7	*Lippiacitriodora*	15-30nm	[52]
8	*Pelargonium graveolens*	20-40nm	[52]
9	*Punicagranatum*	10-50nm	[52]
10	*Nyctanthesarbortristis*	5-10nm	[53]
11	*Rosa hybrida*		[54]
12	*Hibiscus rosasinensis*	14nm	[55]

Scope and Application of Gold Nanoparticles:

The properties of gold nanoparticles can be engineered depending on applications across the field of biology, medicine, environment, and technology [56]. Labeling and bio-imaging of cancer cells are possible due to the surface plasmon resonance. Gold nanoparticles are reported to be used for drug delivery to the cells. Due to the interaction with soft bases, gold nanoparticles are exclusively used for the treatment of cancer. [57-60]. Modern days technology includes the modification of computer chips with gold nanoparticles.[61] Bimetallic gold-palladium is used as an active catalyst for the purification of toxic impurities from the groundwater. Carbon-supported gold nanoparticles are used for selective oxidation of epoxides. [56, 62-64] Hyperthermia based on gold nanoparticles is more effective in cancer treatment without side effects. The optical structures of gold nanoparticles can be tuned by controlling size, shape, and composition. This is because the gold nanoparticles can absorb at the NIR region.

Various gold-based nanoparticles which can be used for detection and diagnosis of cancer can be summarized below.

Nanoparticle Type	**Scheme**	**Target Disease**	**Refrence**
Shell	Silica-gold nanoshells	Breast cancer Prostate Cancer Glioblastoma Liver cancer	[70]
	PLGA-gold nanoshells	Epithelial Carcinoma	[71]
Rod	Gold nanorod	Inflammation	[72]
Hollow	Gold based hollow sphere	Murine Melanomas, Glioblastoma	[73],[74]
Cluster	Gold particle	Breast Cancer	[75]

In short, the application of gold nanoparticles in the field of cancer detection and diagnosis can be represented as a cycle which can be used for to meet the challenges in the near future.

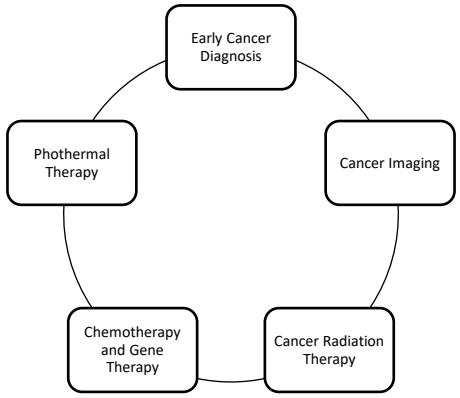

Fig1: Application cycle of gold nanoparticle against carcinoma.

It is well known that diagnosis of cancer is a long term process, so early detection is a must. Gold nanoparticles are also efficient to image and detect the cancer cells at the early stages. The gold nanoparticle can selectively bind with the cancer cells and hence can image the cancer cell and kill them by absorbing at NIR region. The treatment is proven to be very cost-effective since gold nanoparticles can be excited by laser, infrared, or microwave radiation. The selective binding to the cancer cells results in the easy killing

of cancer cells without harming the healthier ones. Above all, combinational therapies are also proven to be more efficient compared to single therapy. Photothermal therapy, including organic photosensitizers, seems to be an alternative to tackle the disease.

Conclusion:

Due to the rapid growth and thrust in the research area of gold nanoparticles, it is always preferred for alternatives and efficient methods. Most of the greener alternatives outlined above are easily available and promising alternatives for synthesizing gold nanoparticles over conventional techniques. The greener approach for the synthesis of gold nanoparticles using plant extracts is far easier, rapid, eco-friendly than traditional methods involving laboratory chemicals. The solution to finding a greener alternative is of high chance in the North-Eastern region of India because of the geographical location and the availability of wide range of flora and fauna. Suppose the green alternative is found to be efficient enough using the plant extract locally available in the area. In that case, the cost of production of nano drug can be minimized, and treatment will be affordable for the middle class as well as people belonging to economically weaker sections. Potent application of gold nanoparticles in the detection and diagnosis of cancer is known, and the efficiency can be further increased on designing the nanoparticle. Gold nanoparticles of various sizes can be of potential use as a drug in the near future.

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